

## Onsite Implementation of a Fish-friendly Vacuum Pump System to Remove Salvaged Fish from Tracy Fish Collection Facility Holding Tanks

### Investigators

#### Donald E. Portz

*Fisheries Biologist  
Fisheries and Wildlife Resources Group  
Bureau of Reclamation  
Denver, CO 80225  
dportz@usbr.gov*

#### Brent Bridges

*Fish Biologist  
Tracy Fish Collection Facility  
Bureau of Reclamation  
Tracy, CA 94514  
BBridges@usbr.gov*

#### Bryan Heiner

*Hydraulic Research Engineer  
Water Resources Research Laboratory  
Bureau of Reclamation  
Denver, CO 80225  
bheiner@usbr.gov*

### Summary

Operations of the south Delta state and federal fish salvage facilities in California require daily collection and holding of fish, and the transport of these fish back to the Sacramento-San Joaquin River Delta, away from the facilities. These functions are of major importance for efficient return and survival of salvaged fishes; however collecting, handling, and transport methods associated with entrainment of the fishes inadvertently may cause harm that the fish salvage facilities are attempting to minimize. The Bureau of Reclamation (Reclamation) Tracy Fish Collection Facility (TFCF) consists of a system of louvers, bypasses, and collecting/holding tanks to reduce the associated fish loss of its pumping operation. The TFCF was originally designed to divert downstream migrating juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from the exported flow and was not intended to divert and salvage the myriad of fish species that are entrained by the pumping practices today. High species and fish totals, along with the documented declining abundance of several fish species, and elevated quantities of vegetative debris are prompting TFCF improvements.

Evaluations and improvements of both the state and federal fish salvage facilities have been ongoing for a number of years. Efforts by California Fish and Game have demonstrated problems with survival of salvaged fish after transport to the release site, and Reclamation researchers have contributed to the understanding of survivorship and injury of fishes associated with the holding tanks at TFCF (Raquel 1989, Portz 2007,

Karp and Lyons 2008). These studies indicate an important need for accelerating and expanding studies at the two salvage facilities.

Fish losses due to entrainment are reduced with improved salvage operations, and the success of these operations is dependent on the survival of screened fishes. Occasionally throughout the year dense schools of fish (*e.g.*, threadfin shad *Dorosoma petenense*) are salvaged at very high numbers and held in recessed cylindrical holding tanks awaiting transfer to the fish hauling truck. High fish densities make it difficult to transfer fish safely using the 1890-L lift bucket and as a result mortality can occur. The lift bucket fish conveyance method has been implicated as one of the greatest sources of stress for fish in the salvage process (Portz 2007) and when fish densities are high they may be transferred without water, crushing and suffocating themselves. Under these situations, a vacuum pump system may be advantageous in transferring sensitive fish species suspended in water without damage to the hauling truck. Fish vacuum pumps are widely used to unload fishing vessel catch and are used at fish hatcheries to load trucks or transfer to other ponds (Davis *et al.* 1993). Studies performed in FY 2010 assessing the effects of this device on fish health and survival were performed at Reclamation's Hydraulics Laboratory and these data are currently being analyzed. Preliminary results show high survival immediately after pumping and at 96-h post pumping. There has been little evidence of damage because of negative pressures exerted on fish and external physical damage from working parts that potentially can lead to direct and indirect mortality. A fish-friendly vacuum pump seems to be a promising method to provide relief to the overburdened lift bucket removal method during high entrainment. A report containing results and recommendations of the fish vacuum pump assessment will be made available fall 2010, before onsite implementation trials would commence.

## Problem Statement

South Delta fish salvage facilities serve a major importance for maintaining the survival of salvaged fishes, however occasional high fish entrainment numbers can be detrimental to fish. High fish densities make it difficult to transfer fish safely using the 1890-L lift bucket and as a result mortality can occur. Under these situations, a vacuum pump system may be advantageous in transferring sensitive fish species suspended in water without damage to the hauling truck, relieving some of the lift bucket burden. A fish vacuum system was successfully tested for physiological stress, damage from negative pressures and working part, and pumping-associated mortality in the hydraulics laboratory. Lab assessments indicate that the fish vacuum system is a safe, fish-friendly viable option for conveying fish and on-site implementation trials should be performed during FY 2011.

## Goals and Hypotheses

### Goals:

1. Determine the methods required to consolidate and effectively move debris and fish with a vacuum pump from the holding tanks to transport trucks.
2. Determine the configuration and set-up required to install a fish vacuum pump in the TFCF holding tank building.

*Hypotheses:*

1. If the fish vacuum pump can be installed and retrofitted for its unique use at the TFCF, then salvaged fish will be moved more effectively using less harmful techniques.
2. If fish and debris can be successfully consolidated to an area of the holding tank, then the vacuum pump can transfer them to the transport truck.

**Materials and Methods**

A thorough evaluation assessing the effects of a fish vacuum pump on fish health, performance, and survival was performed during the spring 2010 and these data are currently being analyzed and will be made ready for reporting by fall 2010. Due to the minimal evidence of negative affects and high survivability of fish tested in the vacuum pump, we suggest that installation be implemented to determine the feasibility of using these devices onsite. We would like to transport the fish-friendly vacuum pump that the Fisheries and Wildlife Resources Group has in Denver, Colorado, to the TFCF. Once at the TFCF, we will investigate on how to retrofit the pump to the existing salvage operation and determine the best use for its tailored use in transferring fish to the hauling truck. No formal scientific analyses will be performed during this second phase of the vacuum pump study, as we are only interested in its implementation and feasibility.

**Coordination and Collaboration**

This project will be a collective effort between Fisheries and Wildlife Research Group staff, and TFCF biologists and O&M staff. This project will be coordinated directly with the Tracy Technical Advisory Team, Tracy Fish Facility Improvement Program manager and the Tracy Fish Collection staff.

**Endangered Species Concerns**

This study may impact wild endangered or threatened species. Initial implementation of the vacuum pump will occur during months that do not experience Chinook salmon, delta smelt (*Hypomesus transpacificus*), and longfin smelt (*Spirinchus thaleichthys*) entrainment.

**Dissemination of Results (Deliverables and Outcomes)**

The primary deliverable will be an installed fish-friendly vacuum pump system and a technical update provided to the Tracy Technical Advisory Team following its implementation. Additionally, information gained on the successes and limitations of the fish collection and salvage process will help guide future improvements in the fish collection, holding, and transport process.

**Literature Cited**

Davis, K.B., J. Newsome, and B.A. Simco. 1993. *Physiological stress in channel catfish, Ictalurus punctatus, harvested by lift net, vacuum pump, or turbine pump.* Journal of Applied Aquaculture 3: 297–309.

- Karp, C. and J. Lyons. 2008. *Evaluation of fish holding at the Tracy Fish Collection Facility, Tracy, California*. Tracy Fish Collection Facility Studies, Volume 39, U.S. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.
- Portz, D.E. 2007. *Fish-holding-associated stress in Sacramento River Chinook salmon (*Oncorhynchus tshawytscha*) at south Delta fish salvage operations: effects on plasma constituents, swimming performance, and predator avoidance*. Doctoral dissertation. University of California, Davis.
- Raquel, P. 1989. *Effects of handling and trucking on Chinook salmon, striped bass, American shad, steelhead trout, threadfin shad, and white catfish salvaged at the John E. Skinner Delta Fish Protection Facility*. California Department of Fish and Game, Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Technical Report 19.